

SMART SENSOR

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INTRODUCTION

- ❑ Main aim of Integrating the electronics and the Sensor is to make an intelligent sensor.
 - ❑ Smart Sensors have the ability to take decisions.
 - ❑ Complete system is called a system on Chip.
 - ❑ Smart Sensors consist of Transduction Element, Signal Conditioning Electronic and controller/processor.
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DEFINITION

□ Smart Sensors are sensors with Integrated Electronics that can perform the following functions :

a) Logic Function

b) Two way communication

c) Make Decisions

Usefulness of Silicon Technology in Smart Sensor

- *A smart sensor is made with same technology as Integrated circuits*
 - *A transduction element either includes thin metal films, Zinc Oxide and Polymeric films*
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SIGNAL CONVERSION EFFECTS

Table 1

Signal Domain	Examples
Radiant Signals	Light intensity,polarization,phase,wavelength
Mechanical Signals	Force ,pressure,flow,vacuum,thickness
Thermal Signals	Temperature , Temperature gradient,heat
Chemical Signals	Concentration,pH,toxicity
Magnetic Signals	Field intensity ,flux density,permeability

Table 2

Signal Domain	Examples
Radiant Signals	Photovoltaic effect, photoelectric effect, photoconductivity, and photo magneto-electric effect.
Mechanical Signals	piezoresistivity
Thermal Signals	Seebeck effect,temperature dependence of conductivity
Chemical Signals	Ion sensitive field effect
Magnetic Signals	Hall effect,magnetoresistance

One problem with silicon is that its sensitivities to strain, light and magnetic field show a large cross-sensitivity to temperature. When it is not possible to have silicon with proper effect, it is possible to deposit layers of materials with desired sensitivity on the top of a silicon substrate. Thus we can have a magnetic field sensor by depositing Ni-Fe layer on the top of a silicon substrate.

MECHANICAL SIGNAL DOMAIN

- ❑ Silicon Can be used for measuring force & pressure because of piezo-resistance effect
 - ❑ By heating a silicon structure having two temperature devices and is brought to air flow then resulting the temperature difference is proportional to square root of flow velocity
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THERMAL SIGNAL DOMAIN

- ❑ Electron devices in Silicon show temperature dependence this property of Silicon can be used for the measurement of Temperature
- ❑ We can measure temperature because seebeck in Silicon is very large

Magnetic Signal Domain

- It can be used for the Construction of Hall Plates & Transistor Structure that are sensitive to magnetic field

CHEMICAL Signal Domain

- * It can be used as humidity sensor or gas sensor
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IMPORTANCE & ADOPTION OF SMART SENSOR

- The presence of controller in smart sensor has led to corrections for different undesirable sensor characteristics which include span variation , non –linearity, cross-sensitivity.

REDUCE COST OF BULK CABLES & CONNECTORS

- By using smart sensor the cost of bulb cables and connectors is reduced

REMOTE DIAGNOSTICS

- It is possible to have digital communication via a standard bus & a built in self-test.

ENHANCEMENT OF APPLICATION

- Self Calibration – It means adjusting some parameters of sensor during fabrication this can be either gain or offset or both.
- Computation : Computation is also allows one to obtain the average, variance and standard deviation for the set of measurements.
- Communication : Communication is the means of exchanging or conveying information.
- Multi sensing : Some smart sensor has to measure more than one physical or chemical variable simultaneously

SYSTEM RELIABILITY

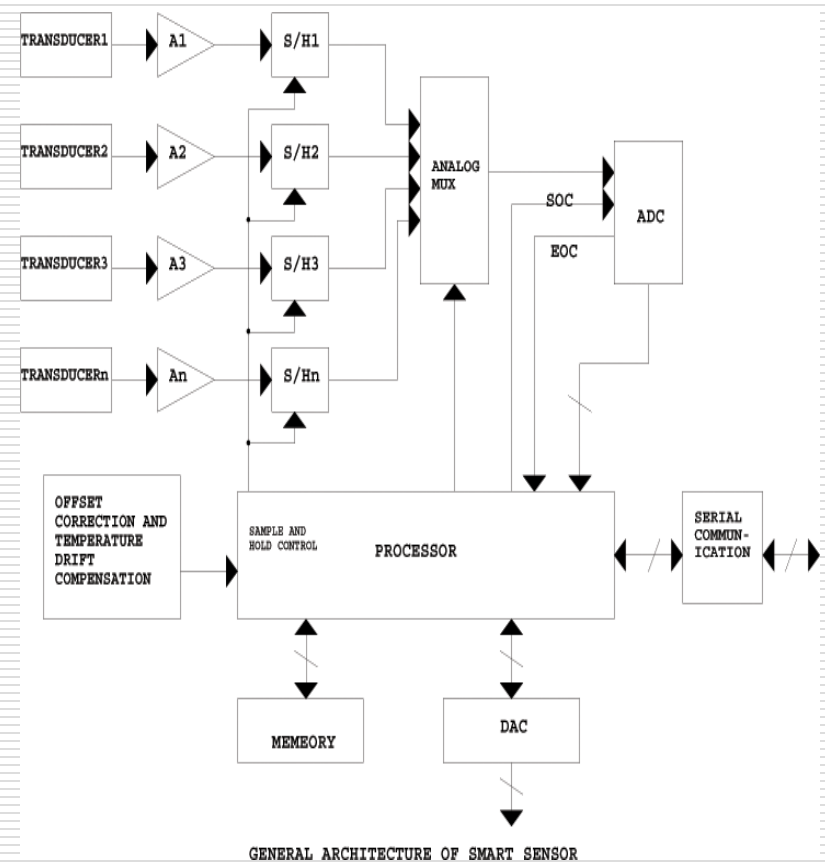
- System reliability is significantly improved due to the utilization of smart sensor

BETTER SIGNAL TO NOISE RATIO

- The electrical output of most sensors is very weak and it is transmitted through long wires lot of noise get coupled by using smart sensor this problem is avoided
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ARCHITECTURE OF SMART SENSOR

- ❑ A general Architecture of smart sensor consist of following important components :
- ❑ Sensing element/transduction element
- ❑ Amplifier
- ❑ Sample and hold
- ❑ Analog multiplexer
- ❑ Analog to digital converter (ADC)
- ❑ Offset and temperature compensation
- ❑ Digital to analog converter (DAC)
- ❑ Memory
- ❑ 8Serial communication and processor



FUNCTIONS WITHIN ELECTRONICS

- Many a times it is required to alter the sensor excitation over the operating range of a SENSOR.
an example of this is SILICON Wheatstone bridge, where the drive voltage is increased with increasing temperature

ANALOG INPUT

- Multiplexing of inputs can be done to avoid duplication of circuits in multiplexing inputs of same type and range are switched to a common front end.

DATA CONVERSION

- * In case of Smart sensor most of the signal processing in digital form this is possible we have an ADC along with an Anti-aliasing filter.
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SUMMARY OF DIFFERENT SMART SENSOR

Optical Sensor

- It is used for measuring exposure in cameras, optical angle encoders

ACCELEROMETER

- * It consists of sensing element and electronics on SILICON

INTREGATED MULTI SENSOR

- This chip was fabricated using conventional Silicon planer processing, Silicon Micro machining and thin deposition technique.
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CONCLUSION

In conclusion, silicon is very suitable material for fabrication of smart sensors. But still a lot of research is required to get benefits of the smart sensor, but from the experience of already existing devices, we can expect that in the coming decade a large number of successful smart sensors will emerge.

References

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